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TECHNICAL REPORT

A CONTINUOUS TRACKING DEVICE FOR PRIMATES

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HOLLOMAN AIR FORCE BASE
NEW MEXICO

April 1960

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Project 6893

Task 68930

A CONTINUOUS TRACKING DEVICE FOR PRIMATES

by

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AIR FORCE MISSILE DEVELOPMENT CENTER

AIR RESEARCH AND DEVELOPMENT COMMAND

UNITED STATES AIR FORCE

Holloman Air Force Base, New Mexico

April 1960

FOREWORD

This report describes a device for measuring continuous tracking ability in primates.

The work was originally supported by the Unusual Environments Section, Engineering Psychology Branch, Aerospace Medical Laboratory, Wright Air Development Center, under Project No. 7184 entitled, "Human Performance in Space Flight", and Task No. 71587 entitled, "Animal Performance under Environmental Extremes". When the portion of the Unusual Environments Section concerned with animal research was transferred from Wright Air Development Center to the Air Force Missile Development Center, this work was documented under Project No. 6893, entitled, "Animal Performance in Space Environments" and Task No. 68930, entitled, "Animal Performance Equipment Development".

The initial design for the device was suggested by Major Frederick H. Rohles, Jr. and the first model was constructed by the Research Institute of the University of Dayton under Contract No. AF 33(616)-6064. Subsequent models were developed and constructed under the supervision of Capt. Marvin E. Grunzke at the Aerospace Medical Laboratory Shops. Wiring was performed by S/Sgt Gordon L. Wilson and A/2C Marion L. Rathbun. Calibration was done by A/1C Loren L. Bartrand.

The authors are indebted to Dr. Richard E. Belleville for his comments and suggestions and to Miss Sylvia Echavarria for secretarial assistance.

ABSTRACT

A tracking task was designed that requires a primate to track a continuously moving target in order to avoid electric shock. The device itself and the training procedures employed are described.

PUBLICATION REVIEW

This Technical Report has been reviewed and is hereby approved for publication.

FOR THE COMMANDER:

Rufus R. Hessberg, Jr.

RUFUS R. HESSBERG, JR.
Lt Colonel, USAF (MC)
Chief, Aeromedical Field Laboratory

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I. INTRODUCTION

One of the most common perceptual-motor tasks demanded of machine operators is that of steering or guiding. Known technically as tracking, this task is usually considered to be of three types: (1) discrete tracking in which the operator must align a movable variable with one of several fixed variables, (2) compensatory tracking in which changes or drift of a movable variable from a prescribed target area requires opposite or compensatory movements by the operator in order to bring the movable variable back within the target area, and (3) continuous tracking which requires the operator by means of a pointer or similar device to follow a continuously moving target.

While the ability to perform these tasks has been thoroughly studied with human subjects, the extent to which it has been investigated with primates and lower animals is limited. Harlow and Butler (Ref. 1) trained rhesus monkeys on a discrete tracking task for food reward. Brown (Ref 2) trained rhesus monkeys on a continuous tracking task in which the target moved in the vertical plane and the subject was rewarded with food when it successfully followed the target for a fixed period of time. With this device, however, once the target began its movement in either direction, it continued in this direction until it reached the limit of its excursion; it then reversed and moved at a fixed rate in the opposite direction.

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The device described in this paper differs from Brown's apparatus in two respects. First, the target moves in an irregular horizontal pattern and second, instead of positive reward, the animal is negatively reinforced with electric shock when it fails to track the target.

II. DESCRIPTION

The device for measuring continuous tracking ability in primates is shown in figure 1. With this apparatus, the subject is required to grasp a pointer and handle unit and to follow a target that moves in an irregular pattern across a 7-inch horizontal plane.

As shown in the functional drawing, (fig. 2) movement of the target is accomplished by two Bodine motors. The slave (target) motor operates at 10 rpm in either a clockwise or counterclockwise direction and is equipped with a 1-inch drive pulley which drives the target. The second or control motor regulates the direction and distance that the target moves. This is a 1-rpm motor fitted with two cams which control the direction of rotation of the shaft of the slave motor and, in turn, control the movement of the target in a right or left direction.

In order to stop the movement of the target when it reaches its maximum excursion in any one direction, two limit switches were incorporated into the apparatus. Their function can be best explained by the following example: if the target moves to the extreme left, the left limit switch stops its movement; when this occurs, the right cam and switch arrangement activates the slave motor which moves the target to the right.

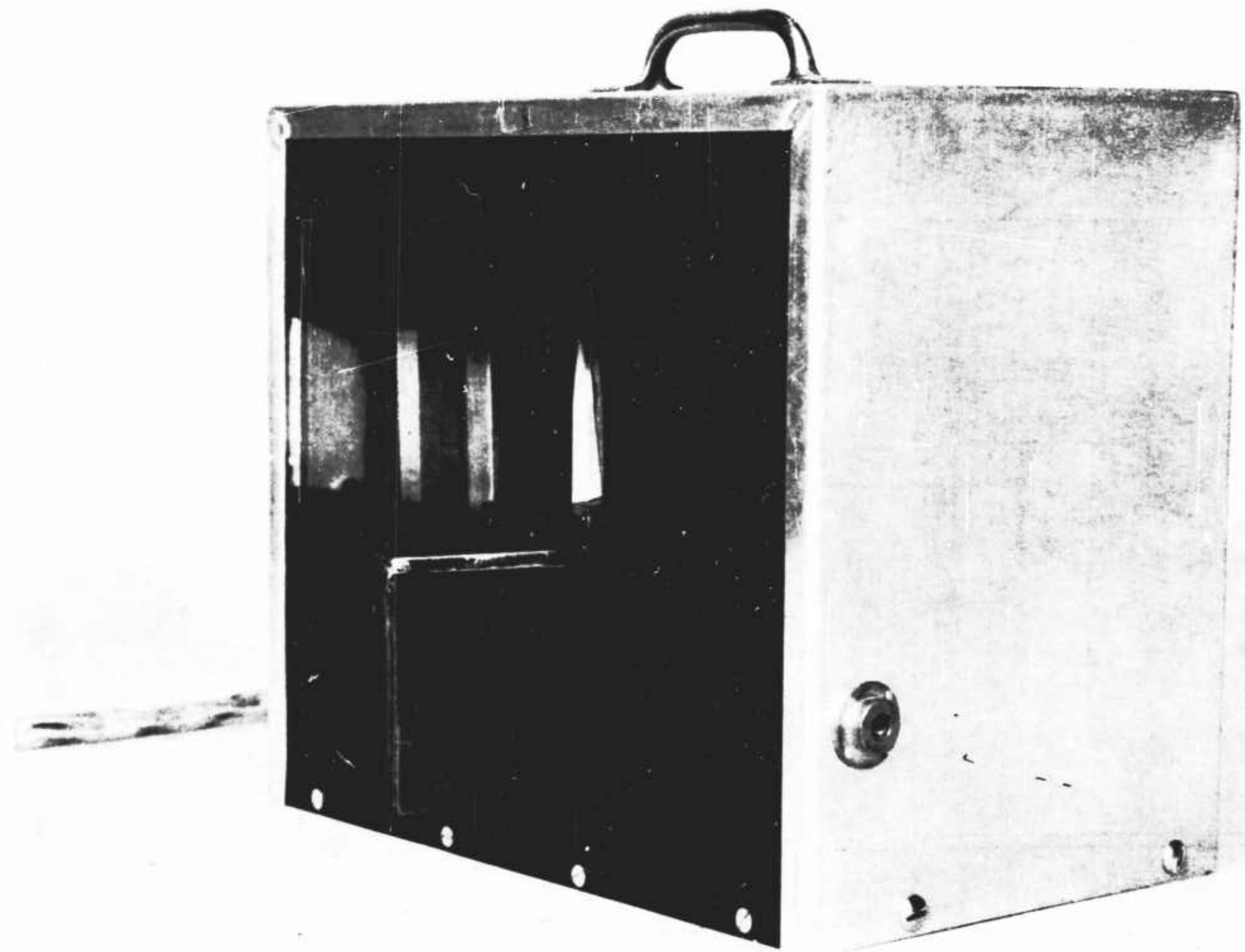

Figure 1. Device for Measuring Continuous Tracking Ability in Primates

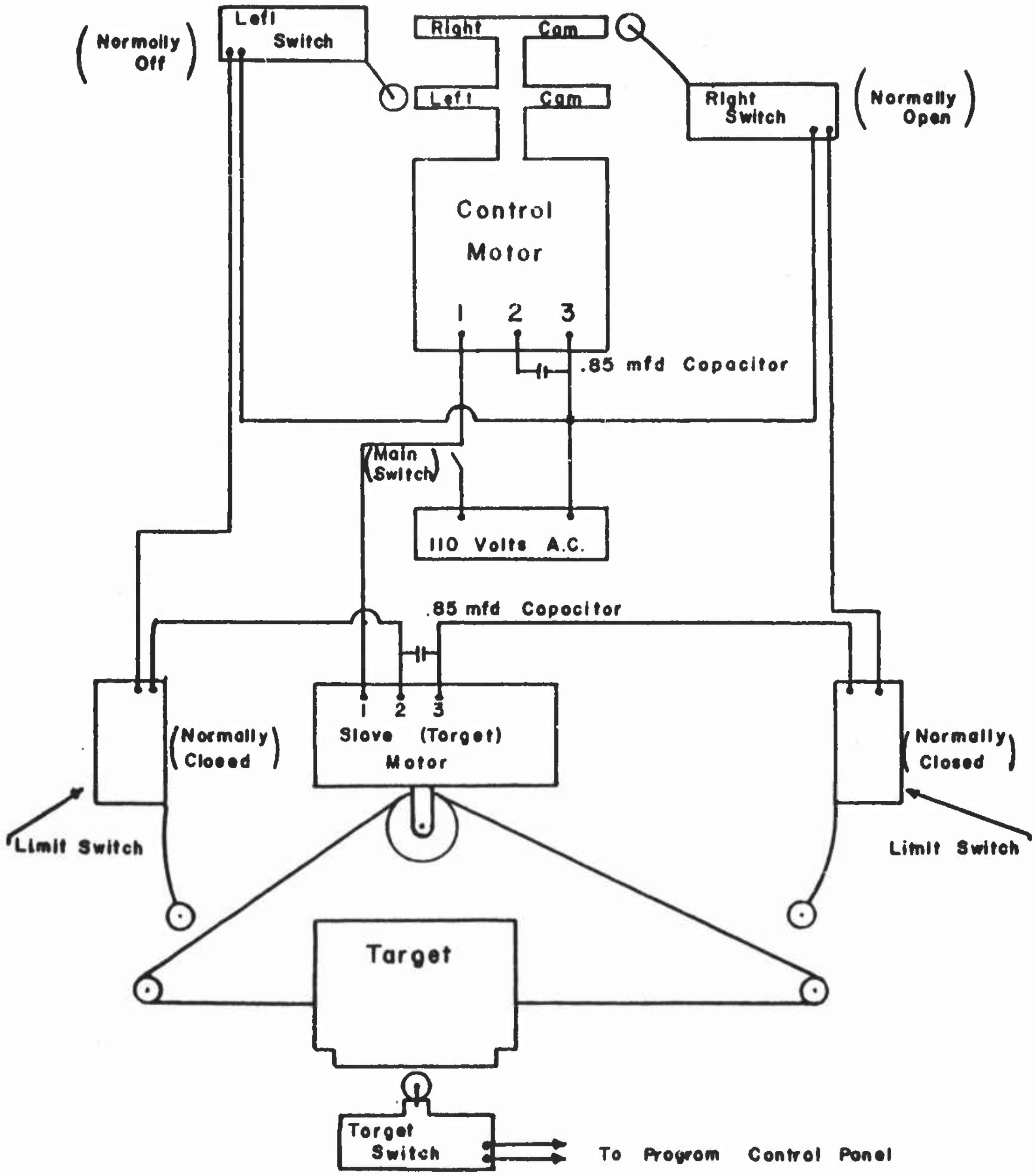

Figure 2. Functional Drawing of Tracking Device

It should be noted that the bottom of the target proper has a raised or offset area similar to a cam. The width of this area determines the size of the scoring area; the scoring area can be further varied by using different sized target plates. An example of the movement of the target for one time cycle is shown in figure 3.

The tracking manipulanda consists of a pointer and handle unit. The pointer is two inches long and one-fourth inch wide and is mounted on a track running parallel to the target. The pistol-grip handle is attached to the pointer and provides the subject a means for directing the movement of the pointer.

When the pointer is in line with the target, the offset area of the target activates the leaf on the tracker microswitch which opens the circuit between the tracker and program control panel. When the target switch is off the raised area of the target, the circuit is closed. Closing the circuit to the program control panel causes delivery of intermittent shocks to the soles of the subject's feet. These occur twice per second and are 90 volts AC, at 15 ma. The program control unit records the time that the subject successfully tracks the target. It should be pointed out that with appropriate programming, positive reinforcement could be used in which a fixed time-on-target is rewarded with food.

The entire unit with the exception of the handle is contained in a steel case, 10 inches long, 6 inches wide and 8 inches high. The front is of one-fourth inch lucite to permit viewing of both the pointer and target. A lamp is provided as a discriminative stimulus which illuminates the target when the task is initiated.

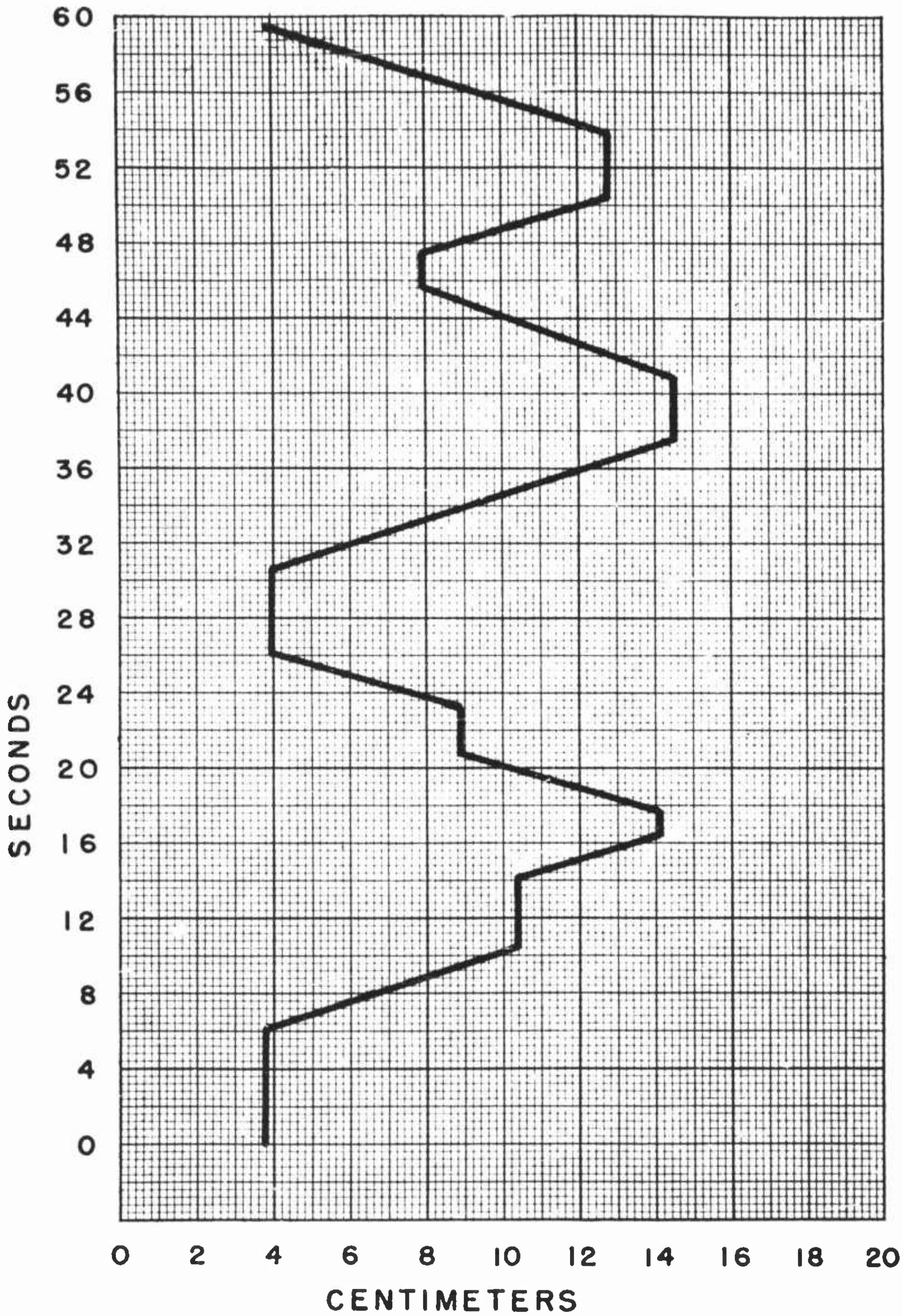

Figure 3. Excursion of the Target in Time

III. TRAINING PROCEDURES

An adult male rhesus monkey served as the subject in testing the tracking task. Throughout the testing the animal was restrained in a Foringer-type primate chair and the tracking device was mounted on the chair so that the handle was easily accessible to the subject and the target was clearly visible.

The training was handled in two phases. In the initial phase the tracking device was used as a discrete tracking task, whereas during the second phase, the task consisted of an extension of this behavior to a continuous tracking task. At the beginning of the training, the subject's hand was taped to the handle and during this period the target motors were de-activated and movement of both the target and pointer-handle unit was accomplished manually by the experimenter. With the subject seated in the chair, the experimenter first aligned the target and pointer at the extreme left side of the tracking area for approximately 30 seconds. Then the experimenter moved the target only to the extreme right side of the tracking area without moving the pointer. This caused the subject to receive shock. After approximately 5 seconds of shock, the experimenter moved the pointer-handle unit and in turn the subject's hand which was taped to the handle in line with the target causing cessation of the shock. Then after approximately 10 seconds, the target was moved to the extreme left of the tracking area and the same procedure of shocking the animal and moving of the pointer to stop the shock was repeated. This continued until the subject accomplished the movement of the pointer without help from the experimenter. When the subject began making these responses, the distance of target movement was reduced; however, the task was still one requiring discrete tracking.

Training using this procedure was conducted for four, 15-minute sessions per day with a 2-hour rest between sessions. During the rest periods, the lamp illuminating the target was turned off to allow the subject to discriminate between the tracking and rest periods. On alternate days the subject's left hand was taped to the tracker handle.

After approximately 6 days, training was transferred from a discrete to a continuous tracking task. The drive motors for the target were connected, although manual operation of the pointer-handle by the experimenter remained. This phase of the training continued for approximately 10 days after which the subject's hands were no longer taped to the handle. The time that the subject successfully tracked the target was recorded.

IV. RESULTS

After 20 days of performance following the removal of the tape from the subject's hands, the animal consistantly was able to track the target between 12.5 and 13 minutes out of every 15-minute session. During this time the raised or offset area of the target was one-half inch wide. In addition, the subject responded immediately by tracking as soon as the lamp in the tracker was illuminated. To state that the tracking performance was always smooth and well coordinated would be incorrect. Much of the behavior was coarse and consisted of random movement of the handle back and forth across the tracking area. This was believed to be a function of both attention and early training because when the subject was attending the target, smooth and well coordinated performance was observed.

V. SUMMARY AND CONCLUSIONS

While primates have been trained to perform on several types of tracking devices, they have not been trained to track a target that moves continuously in an irregular pattern. Behavior of this type is similar to that found in many human machine operation functions. In order to measure this ability with primates, a continuous tracking device was developed and a rhesus monkey was trained to consistently track the target 80 percent of the time. It is concluded that with additional training the percentage of successful tracking time could be increased. Extensions of this study should develop a device for remote manipulation of the pointer and the addition of a third dimension. Such a device would resemble more closely the task required in most machine operations and particularly in piloting aircraft.

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2. Brown, W. L. Personal Communication, 1956.

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